Monday, December 14, 2020

Virtual Meeting via Zoom
6:00 –7:00 p.m.

HGS Members $15 Non-Members $35 Students $5
https://www.hgs.org/civicrm/event/info?id=2255
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
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Using Fluid Inclusion Salinity Data to Reduce Uncertainty in Petrophysical S_w Calculation – New Application of an Old Technique in Unconventional Reservoirs

Main objectives of petrophysics in hydrocarbon exploration are assessing lithology and calculating porosity and fluid saturations to identify potential pay zones. Fluid saturations are further used to estimate in-place hydrocarbon volume – the ultimate basis of economic value. Formation water salinity is one of the most important inputs in the calculation of fluid saturations. During early-stage exploration, formation water salinity in the target reservoir is typically unknown, which brings large uncertainty to resulting petrophysical evaluations. In such cases, fluid inclusions can be used as an independent tool to provide guidance on formation water salinity. The influence of salinity on S_w is particularly strong under 80 ppk NaCl equivalent concentrations and in low porosity (PHI<10%) reservoirs.

Fluid inclusions are small volumes of pore fluid (water, oil, gas or a mixture of these phases) that were trapped in minerals formed during the diagenetic history of a reservoir. They may represent multiple episodes in the fluid history of the rock. Fluid inclusion assemblages need to be correlated with diagenetic stages and tectonic episodes throughout the burial history of the reservoir to establish their relative and, if possible, absolute timing. This is typically achieved via careful petrography and basin modelling workflows. Then, estimated formation water salinity, inferred from fluid inclusions, can be integrated with petrophysics to provide robust exploration-stage petrophysical outputs.

We present several case studies spanning source rock plays (Avalon & Wolfcamp Fm, Permian Basin, La Luna Fm, Colombia), and tight carbonates (Yeso Group, New Mexico NW Shelf, Austin Chalk Fm, Gulf Coast). In all these examples, water salinity over geological time, reconstructed from fluid inclusions, converges to the salinity ranges of produced water from the formations under study. Furthermore, we prove the method valid over a wide range of salinities (50-200 ppk $NaCl_{eq}$) and in cases where inclusion salinities increase (Austin Chalk), decrease (Avalon & Wolfcamp) or appear stable (La Luna) through the burial history.

In the case of La Luna formation, fluid inclusion data from fracture/vug-filling minerals were used to define the "best technical case" during early exploration. Subsequent well tests confirmed formation water salinity estimations from the fluid inclusion study. This validation was one of the key drivers in extending the application of the method to other basin evaluations in South America and the onshore US.

Diagenetic studies, fluid inclusion analysis and the methods to calculate petrophysical fluid saturations are established tools in the exploration toolkit. Our results demonstrate that closer integration of these fields adds significant value to the exploration and appraisal process by reducing uncertainty around fluid saturations, in-place volumes and ultimately acreage valuation. ■

Biographical Sketch

Benedek Gál is senior geologist in the Global New Ventures organization at ConocoPhillips. He received his MSc and PhD from Eötvös Loránd University in Budapest, Hungary while working on ore petrology, geochemistry, and fluid inclusions on the ore deposits of the Duluth Complex in Minnesota . He worked as project geologist on mineral exploration projects in Finnish Lapland, Anatolia (Turkey) and the Atacama region (Chile) before joining ConocoPhillips in 2014. Since then he was involved in research and technology development in geochemistry, basin modeling and exploration for new hydrocarbon plays, conventional and unconventional, across the globe. He is interested in integrated workflows that link data on all scales to produce predictive maps and models to identify undiscovered hydrocarbon resources.